Seasonal activity and reproductive characteristics of an oldfield-grassland snake assemblage: Implications for land management

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ABSTRACT – We examined the seasonal activity and aspects of reproduction of a snake assemblage during September 2001-September 2004 at the James H. Barrow Field Station in northeastern Ohio. Peak activity for the five species (*Lampropeltis triangulum, Nerodia sipedon, Storeria dekayi, S. occipitomaculata, Thamnophis sirtalis*) captured under cover boards occurred in June and August. June and July were the months with most gravid females, and August was associated with a peak in numbers of juveniles observed for most of these species. The temporally localized peak of activity should be kept in mind when considering mechanisms such as burning, disking, or mowing to maintain the integrity of this vanishing habitat.

NORTH America has lost 80% of grasslands since the 1800s (Brennan and Kuvlesky, 2005). In the East, encroachment of forest is the main cause, whereas in the Midwest fragmentation from agriculture is most responsible for this loss (Brennan & Kuvlesky, 2005). In Kansas, the collapse of a diverse grassland herpetofauna was monitored during an extended period of fire suppression (Fitch, 2006a,b). Only 0.5% remains of Ohio's original 2,591 km^2 native tallgrass prairie, and secondary grassland habitat, such as pastures and hayfields have declined 61% and 46%, respectively, since 1950 (Swanson, 1996). We undertook a snake monitoring project in secondary grassland sites at a biological preserve in the Glaciated Allegheny Plateau section of northeastern Ohio to understand the seasonal activity patterns and reproductive seasons of this segment of the biota in the context of making sound land management decisions of northeastern grasslands.

STUDY SITE AND METHODS

The James H. Barrow Field Station (JHBFS) is a 121.4 ha reserve that is privately owned and operated by Hiram College and is located in Hiram Township, Portage County, Ohio. Located in the Glaciated Allegheny Plateau region in northeastern Ohio and founded in 1960, JHBFS contains habitats that range from various stages of oldfield succession and pasture to 67% forest coverage of a primarily Beech-Maple community. Creeks and artificial ponds are present on the property. The station is surrounded by farms and rural residences. This study ran from September 2001 to September 2004. In each of three oldfield sites, 10 1X1 m cover boards of untreated plywood were set 2 m apart from one another along a transect, where they were exposed to direct sunlight for most of the day. Over the course of the study, 30 cover boards were checked on 35 days during May–September. Because, for logistical reasons, cover boards were not checked prior to May, our conclusions speak to the seasonal activity patterns from May onwards. Cover boards were checked in the morning, while the ambient temperature was cool or cold and presumably before snakes became active. In this regard, long term average monthly high air temperatures during May–October ranged 15.6–26.7 C and monthly average low air temperatures for this same period ranged 10.0–21.1 C.

Snakes that were captured under the cover boards were identified to species, sexed, and their body lengths were measured in cm as snout-vent length (SVL). A subset of snakes was individually

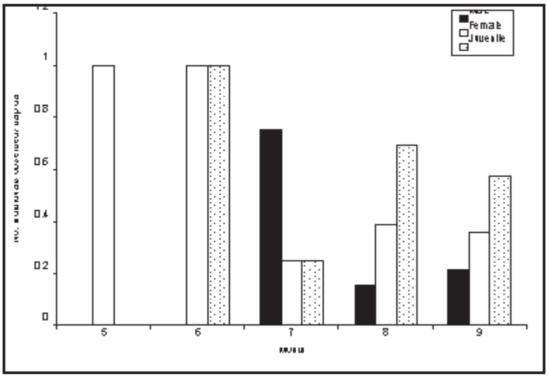

Figure 1. Seasonal activity of males, females, and juveniles of the Milk snake (*Lampropeltis triangulum*) during May-September at JHBFS.

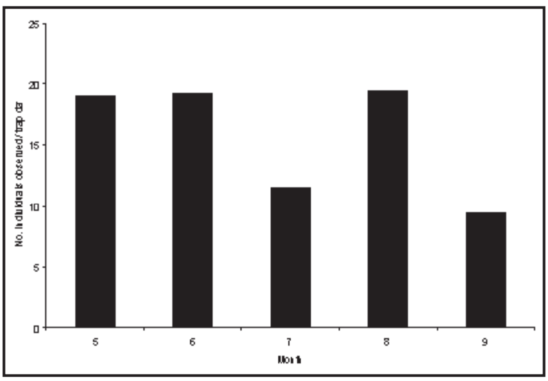

Figure 2. Seasonal activity of five species of snakes during May-September at JHBFS.

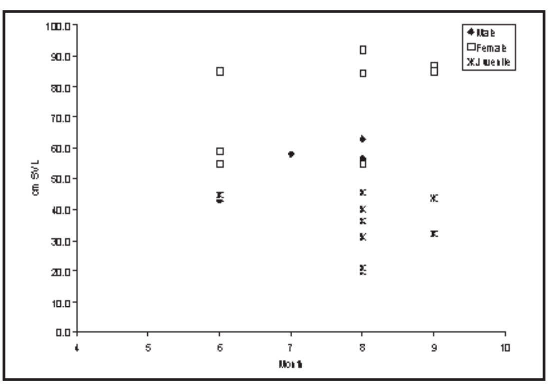

Figure 3. Seasonal distribution of body sizes of males, females, and juveniles of the Milk snake (*Lampropeltis triangulum*) during May-September at JHBFS.

marked with AVID Passive Integrated Transponder (PIT) tags, and a subset of new animals was used for the seasonal distribution of body size scattergrams. All other figures are based on total numbers of individuals observed. Common names follow Collins & Taggart (2002). Means are followed by ± 2 standard deviations, and statistical significance was recognized at $p < 0.05$.

RESULTS

Lampropeltis triangulum (Lacepede, 1788). With 44 observations, the Milk snake was captured during May–September and most active in June (Figure 1). The snake assemblage generally was active during May–September but appeared to peak bimodally during May–June and again in August (Figure 2). Males were most noticeable in July, whereas females were most noticeable during May–June (Figure 1). Juveniles were captured most in June and again during August–September (Figure 1) with the smallest individuals apparent in July (Figure 3). From a small sample, Mean body size of males (mean = 52.9 ± 8.92 cm SVL; range = 43.0–63.0; n = 5) was significantly different (z = -3.245; p < 0.000) than that of females (mean = 75.3 ± 15.92 cm SVL; range = 55.0–92.0; n = 8).

Nerodia sipedon (Linnaeus, 1758). With 22 observations, the Northern water Snake was captured during May and July–September and was most noticeable in May and August (Figure 4). The snake assemblage generally was active for all five months with two peaks in activity (Figure 2). Males were scarcely captured; however, females peaked in numbers in May and again in August (Figure 4). Juveniles were most apparent in August (Figure 4), the two smallest of which measured 32.5 and 33.0 cm SVL. We measured three males (38.0, 46.0, 69.0 cm SVL) and one female (63.0 cm SVL).

Storeria dekayi (Holbrook, 1836). With 102 observations, the Brown Snake was captured during June–September with generally high numbers of sightings until September (Figure 5). The snake assemblage of JHBFS generally was active during all five months; however, the peak activity for the assemblage was bimodal (Figure 2). Males were more active during the latter part of the season than at the beginning, whereas female activity climbed in June and July and sharply decreased thereafter (Figure 5). Juveniles were evident in June, August and September, and peaked in August (Figure 5). The smallest gravid female measured 25.0 cm SVL. The gravid condition was most evident during June–July, the incidence of which sharply decreased and ended in August (Figure 6). This pattern to nesting season was similar to that of the snake assemblage generally of the station (Figure 7). The body size distribution of this species indicates that the peak in juveniles at the end of the season (Figure 8) was associated with a peak in parturition in August (Figure 6). The seasonal distribution of Brown Snake body sizes also suggests sexual maturity by the following August, which could explain larger numbers of males at that time in association with fall breeding. The mean body size of males (24.1 ± 2.9 cm SVL; range = 20.0–31.1; n = 22) was significantly different (t = -6.306; df = 56; p < 0.000) than that of females (28.4 ± 2.2 cm SVL; range = 25.0–34.0; n = 36).

Storeria occipitomaculata (Storer, 1839). With 19 observations, the Northern redbelly Snake was active during June–September with most observations occurring during June followed by a lesser peak in September (Figure 9). This observed pattern in the Redbelly snake is shorter than that of the snake assemblage generally at the station (Figure 2). Likewise, peak patterns of its activity (Figure 9), although bimodal, are somewhat different than of the entire assemblage (Figure 2). No males of this species were captured in this study; however female activity peaked in June, and juvenile activity peaked in September (Figure 9). In this connection, juveniles ranging 9.5–10.0 cm SVL were taken during August–September. The smallest gravid female measured 25.0 cm SVL, and all females captured during June–July were gravid, which is one month shorter than that reported for the snake assemblage generally at the station (Figure 7).

Thamnophis sirtalis (Linnaeus, 1758). With 321 observations, the Common garter Snake was recorded in all five months of the study, with most observations having occurred during May–June and again in August (Figure 10). Both of these patterns mirrored those of the snake assemblage generally at the station (Figure 2). Males were active in each of the five months studied but especially so during May–June and in August (Figure 10). Females were also active throughout the season but numbers tapered off after a peak during May–June (Figure 10). Juveniles, also active throughout the season, were especially noticeable in May and August (Figure 10). The

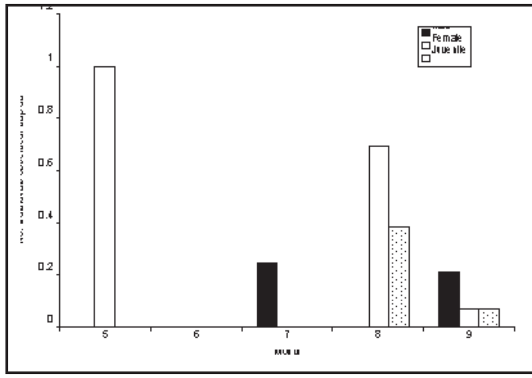

Figure 4. Seasonal activity of males, females, and juveniles of the Northern water snake (*Nerodia sipedon*) during May-September at JHBFS.

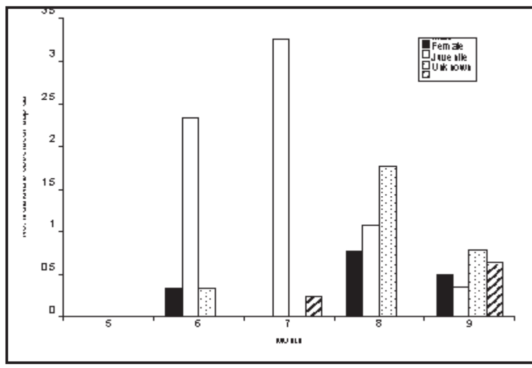

Figure 5. Seasonal activity of males, females, juveniles, and unknown individuals of the Brown snake (*Storeria dekayi*) during May-September at JHBFS.

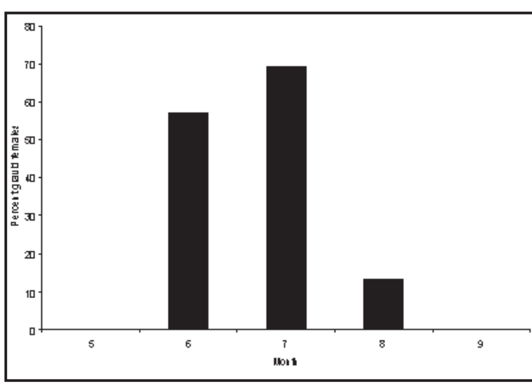

Figure 6. Seasonal frequency of gravid females of the Brown snake (*Storeria dekayi*) during May-September at JHBFS.

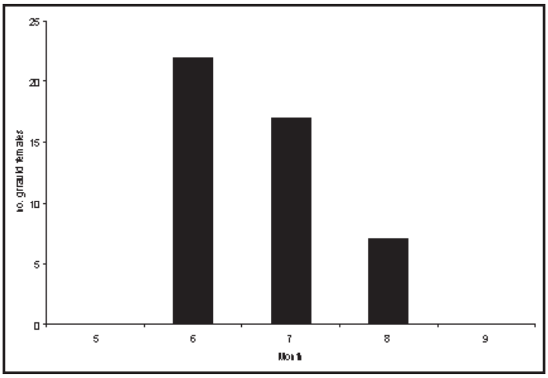

Figure 7. Seasonal distribution of gravid females of the Brown snake (*Storeria dekayi*), Redbelly snake (*S. occipitomaculata*), and Common garter snake (*Thamnophis sirtalis*) during May-September at JHBFS.

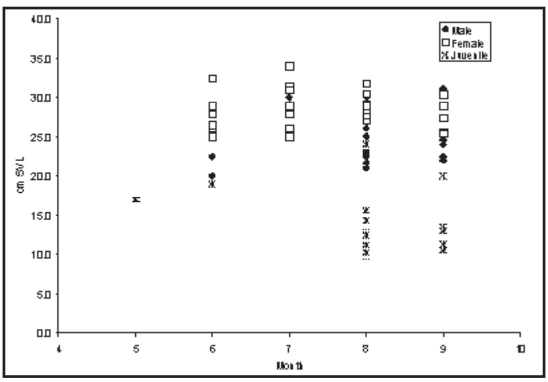

Figure 8. Seasonal distribution of body sizes of males, females, and juveniles of the Brown snake (*Storeria dekayi*) during May-September at JHBFS.

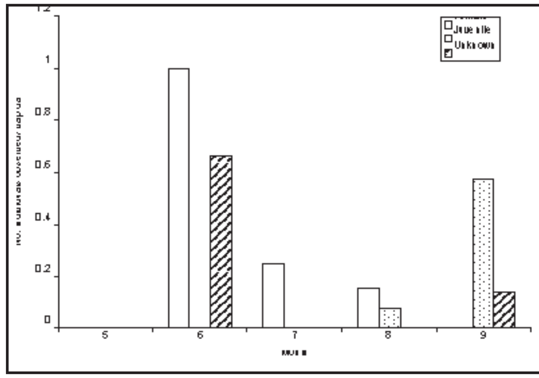

Figure 9. Seasonal activity of females, juveniles, and unknown individuals of the Redbelly snake (*Storeria occipitomaculata*) during May-September at JHBFS.

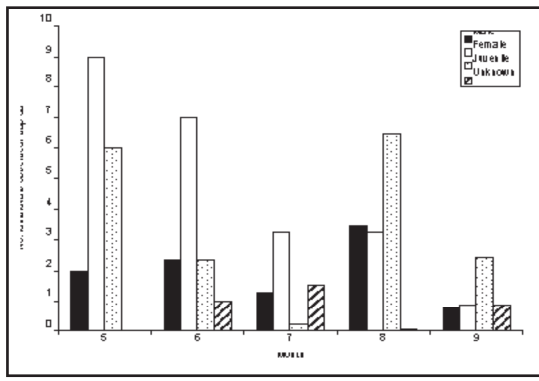

Figure 10. Seasonal activity of males, females, juveniles, and unknown individuals of the Common garter snake (*Thamnophis sirtalis*) during May-September at JHBFS.

smallest gravid female measured 45.0 cm SVL, and the highest incidence of gravid females occurred during June–July, after which time gravid females were scarcely present in August and none thereafter (Figure 11); a pattern that was similar to that of the snake assemblage generally (Figure 7). The bimodal peak in male activity could represent two mating periods, between which females were parturient. The May peak in juveniles (Figure 10) represented overwintering juveniles that were born as late as the previous August and September (Figure 12), which was the second peak in activity of juveniles (Figure 10). The seasonal distribution of those body sizes suggests that sexual maturity occurred during the following June in males and as early as the following August for females (Figure 12). This growth rate would explain the scarcity of juveniles during June–July (Figure 10) replaced by young adults (Figure 12). Mean body size of males (38.5 + 4.9 cm SVL; range = 29.0-53.0; n = 49) was significantly different (t = -13.13; df = 90; $p <$ 0.000) than that of females (53.5 + 6.0 cm SVL; range = 45.0-68.5; n = 43).

DISCUSSION

The snakes of JHBFS adhered to unimodal or bimodal activity patterns that typify temperate zone snakes (Gibbons & Semlitsch, 1987). Strong seasonal pulses of activity are evident in snakes of Indiana (Minton, 2001), northern Ohio (Conant, 1938), Pennsylvania (Hulse *et al*., 2001), and Connecticut (Klemens, 1993). The same is true in southerly populations such as South Carolina

(Gibbons & Semlitsch, 1987) and southern Florida (Dalrymple *et al*., 1991), where frequency of winter or dry season activity tends to be higher than in northern sites. At JHBFS, the assemblage and three species (Northern water snake, Redbelly snake, Common garter snake) exhibited bimodal peaks in their seasonal activity, and two species (Milk snake, Brown snake) exhibited a unimodal peak in their seasonal activity. Although we do not know the extent to which snakes were active snakes in April, by May activity was pronounced and by September activity had waned in this population. Within this five or six month activity season, reproduction was likewise constrained. For example, the frequency of gravid females among the four species for which we had data peaked in July. For one species, the Redbelly snake, the season also ended in July. For the other two species, the Brown snake and Common garter snake, remaining gravid females were collected in August. The latter two snakes appeared to have given birth as late as September, and the Common garter snake may have mated a second time the previous month. For some species, such as the Redbelly snake, birthing seasons are relatively constant across its geographic range (e.g., Palmer & Braswell, 1995; Dundee & Rossman, 1996; Minton, 2001), whereas for others, like the Brown snake and Common garter snake, birthing seasons seasonally expand as one proceeds southward in their geographic ranges (e.g., Dalrymple *et al*., 1991; Larsen *et al*., 1993; Meshaka, 1994; Minton, 2001).

Consequently, it is safe to conclude that above-ground risks to individual snakes are highest beginning at least in May (risks prior to May are unknown this study) and last through August after which time surface activity declined precipitously. In many cases, as in the Northern redbelly snake, the risk is directed to gravid females that are thermoregulating in grass tussocks or under the cover boards. Likewise, the geographic variation among patterns speaks to the importance of region and site-specific data concerning life history phenologies, such as seasonal activity and reproductive seasons, for predictive power in hypothesis testing and in accuracy of management strategies.

In this connection, a wide range of management options are available to maintain grasslands within which these species occur. With mixed success,

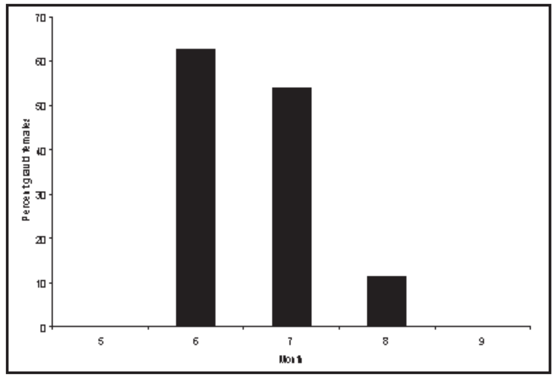

Figure 11. Seasonal frequency of gravid females of the Common garter snake (*Thamnophis sirtalis*) during May-September at JHBFS.

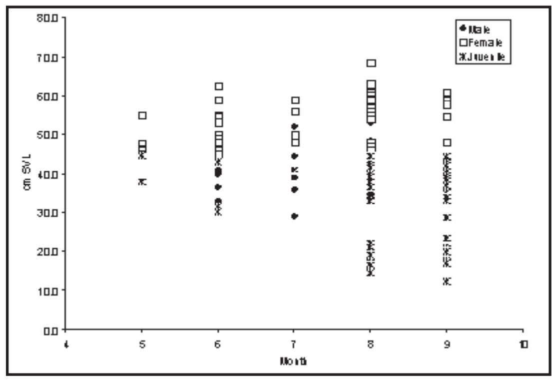

Figure 12. Seasonal distribution of body sizes of males, females, and juveniles of the Common garter snake (*Thamnophis sirtalis*) during May-September at JHBFS.

these include techniques such as burning (e.g., Greenfield *et al*., 2003; Fynn *et al*., 2004), disking (Greenfield *et al*., 2003), and mowing (Fynn *et al*., 2004). For the grasslands in the Midwest, a diverse program of burning, haying, mowing, and grazing has been proposed for management (Swengel, 1998). The former method affects earthworm abundance (James, 1988), an important food item for The Redbelly snake, Brown snake, and Common garter snake, the latter two of which are likewise affected by fire (Wilgers & Horne, 2006). Each of these management protocols can bring with them potential injury to wildlife. In light of our findings, we proffer here that the timing of management techniques, such as those mentioned above, be considered in relation to segments of the faunal community whose phenologies could be subject to negative impacts by summer land management programs. Thus, for the snake fauna of JHBFS, which we feel represents the fauna of neighboring parts of northeast Ohio, such activities are safest done after September.

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